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September 29, 1998

Mr. John Vierow, P.E.
MS R-2-3
Science Applications International Corporation
11251 Roger Bacon Drive
Reston, Virginia
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Subject: Letter of Transmittal – Report Review

Dear Mr. Vierow:

Enclosed are my comments on the September, 1998 version of a draft risk assessment report entitled "Estimating the Risk from the Disposal of Solvent-Contaminated Shop Towels and Wipes in Municipal Landfills". The comments are organized according to the Charge to Reviewers you sent with your September 9, 1998 Letter of Transmittal.

Overall, I believe the Research Triangle Institute has done a capable job of risk assessment, but certain difficulties limit how the data may be used. As discussed in the comments, the major issues are: (1) the waste stream characterization is inadequate to characterize the present work as a risk assessment of shop towel disposal (rather it is a risk assessment of solvent loading into a landfill); and (2) there is insufficient analysis to assure that the applied parameter values meet the requirement for a "high-end" exposure pertinent to making regulatory decisions.

If you have any questions or require further assistance, please feel free to call me at (978) 692-9090 extension 225.

Regards,

Bradley W. Schwab, Ph.D.
Principal Toxicologist

Comments on the Draft Report

"Estimating the Risk from the Disposal of Solvent-Contaminated Shop Towels and Wipes in Municipal Landfills"

(Research Triangle Institute, September, 1998)

by

Bradley W. Schwab, Ph.D.; Ogden Environmental and Energy Services Company, Inc.

Introduction

Research Triangle Institute (RTI) prepared a human health risk assessment of potential exposures arising from disposing shop towels or "wipers" containing organic solvents to unlined municipal landfills. This information was requested by the U.S. Environmental Protection Agency, Office of Solid Waste (EPA OSW), presumably to assist in a determination of whether this waste stream, currently classified as F001 through F005 waste under the Resource Recovery and Conservation Act (RCRA) may be exempted. Science Applications International Corporation (SAIC) was contracted by EPA SOW to organize a peer review of this document. The following review was conducted under a subcontract to SAIC and provides comments related to specific requests made by SAIC in their Charge to Reviewers. The following sections are formatted according to this Charge.

A. Overall Risk Assessment

1. Major Data or Methodological Gaps

Loading term: The largest uncertainty in the risk assessment is the landfill loading term. There is really no characterization of the waste stream in the report. Rather, assumptions are made to identify compounds (F001 through F005 listed) and the mass of releasable solvent (equivalent to the mass of the wiper times the number of wipers disposed). No study is cited to substantiate the releasable mass from the wiper, and the number of wipers disposed is accredited to a "recent study" by EPA OSW, but no citation is provided so that a reader might review the data. Even the weight of the wiper is accredited to a personal communication. Without an accurate loading term, the assessment as written may over- or underestimate the risk of wiper disposal. None of this really affects the risk assessment as performed, but it obviates the ability to use the risk results directly to say "yes or no" to wiper disposal, or to limit wiper disposal to some specific number of pieces. Such decisions would only be appropriate if the waste stream were legitimately characterized. It would be more accurate to state that this is a risk assessment of loading approximately 300 to 1300 grams of solvent per day into landfill cells (i.e., 30 to 120 wipers/day x 10.48 g/wiper). With this understanding, risk managers could later "translate" the mass load limits suggested by the risk assessment into wiper disposal limits using specific information concerning what amount of solvent a wiper might release.

Landfill parameters: The ultimate outcome of the risk calculations in this report seem to prove that a statement made in Section 3 fallacious. Section 3.1 states "The highest risk by each pathway individually is not necessarily the location demonstrating the highest overall risk." While I would have agreed with this as a general concept, the results shown in Section 6 indicate that, depending on which compound is being evaluated, either the air or the groundwater pathway dominates significantly. As such, climactic conditions

representing high-end exposures for air or groundwater may indeed reveal higher overall risks than the Houston site used for high-end combined risks. Evaluation of this uncertainty could be accomplished by running the risk assessment on the "single medium" high-end sites (one for air, one for groundwater) to investigate which would cause the highest overall risk.

Other release mechanisms: RTI has selected reasonably standard exposure pathways for evaluation, which may be adequate. However, an alternative release mechanism comes to mind, which should be checked to assure that it does not suggest higher exposures than those modeled. Specifically, RTI models volatile flux to the atmosphere as essentially a diffusion process. While this is typical, it is of note that under the Clean Air Act, EPA has evaluated the potential for "non-methane hydrocarbon" emissions from municipal landfills as a function of methane production of the unit[1]. This alternative method is empirical and probably conservative, but it implicitly suggests that landfill gases may be subject to advective transport, and may exceed the flux rates calculated for the diffusion process. It may be of use to determine if higher emission rates (and hence higher exposures) would be predicted using an "AP-42" approach to the problem.

2. Over- or Underestimation of Risk

There are three instances of concern for potential underestimation of risk:

Possible inadequate selection of high-end exposure parameters: While I do not believe the assessment underestimates health risk in any real sense, due primarily to the conservatism of the toxicity benchmarks, I am not sure the assessment as conducted adequately estimates the level of risk appropriate to making a regulatory decision. As mentioned above, it is not certain that a true "high-end" risk estimate has been made until evaluations of climactic conditions favoring higher air and groundwater releases (separately) are conducted. Further, it appears that, with the exception of selecting a high-end landfill site, other exposure factors (e.g., inhalation rates, surface area, duration and frequency of exposure) tend to be median values. As such, it is uncertain that RTI has calculated the overall high-end exposure discussed by EPA in its Exposure Assessment Guidance[2]. In this regard, it is notable that the risk estimates for the high-end landfill (Houston) and the central-tendency landfill (Lincoln) are almost identical. This may suggest that the risk estimate is not terribly sensitive to landfill parameters and that use of other high-end exposure factors are required to obtain the conservative assessment required.

No cancer risk assessment of tetrachloroethylene: It is notable that the present risk assessment does not evaluate the potential cancer risk of tetrachloroethylene. The carcinogenicity of this compound is controversial and it may be appropriate to neglect this toxic endpoint. However, this approach would be substantially different from other regulatory initiatives and therefore require substantial justification. Neglecting the potential carcinogenicity of tetrachloroethylene would be a major departure from U.S. EPA policy evidenced by tetrachloroethylene's Maximum Contaminant Level Goal, as well as typical treatment of the compound under CERCLA or RCRA Corrective Action investigations. Without a cancer risk characterization and discussion of this alternative interpretation of toxicity, it is not possible to understand whether the approach leads to a significant underestimate of cancer risk.

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1 See Compilation of Air Pollutant Emission Factors ("AP-42") Volume 1: Stationary and Point Sources. Section 2.4.

2 Federal Register 57, no. 104. May 29, 1992. Pages 22888-22938.

Possible missing receptor: RTI has not considered workers at the landfills. These receptors would not be expected to have high risk from groundwater pathways, but their proximity to solvent sources may make inhalation exposures particularly intense. This would be true especially for machine operators responsible for moving waste and maintaining the daily configuration of wastes in the cells. For compounds contributing high risk by the inhalation pathway, sole use of off-site receptors may therefore result in an underestimate.

3. Linear Interpolation

To the extent the release mechanisms have been correctly modeled (see comment on landfill emissions above and comments on the partitioning model below), I believe linear extrapolation of the results could be done within the constraints of the model assumptions. In this regard, the partitioning model used by RTI contains the implicit assumption that the three "compartments" (solid, liquid, air) in the landfill mass are within their capacity to maintain contaminant in an adsorbed or dissolved state. At some point, contaminant mass loading may be so great as to exceed the solubility limit of the compound, and a fourth phase; that of a non-aqueous phase liquid (NAPL), would appear. When NAPL exists, neither the volatilization nor leachate equilibrium models used by RTI remain valid. As such, linear interpolation to higher mass loads than were modeled in the risk assessment should be limited to levels not anticipated to result in NAPL.

The so-called saturating concentration C_{sat}, has been discussed in several U.S. EPA documents, most notably the Soil Screening Guidance.[3] A formula for calculating C_{sat} is:

$$C_{sat}\ (mg/kg) = \frac{S\,x\,(K_d\ x\ \rho_b\ +\ \theta_w\ +\ H'\ x\ \theta_a)}{\rho_b}$$

Where,

S	=	water solubility of compound (mg/L)
K_d	=	partition coefficient (= K_{oc} x f_{oc}) (L/kg)
ρ_b	=	bulk density of soil (kg/L)
θ_w	=	water filled porosity (L/L)
θ_a	=	air filled porosity (L/L)
H	=	dimensionless Henry's Law coefficient

4. Appropriateness and Conservativeness of Assumptions

As mentioned above, it is unclear whether the mix of central tendency and high-end exposure parameters actually achieves the high-end exposure estimate specified by U.S. EPA guidance on exposure assessment. Suggestions for checking the conservatism of the estimate were given previously.

A second issue of appropriateness relates to the use of degradation rates in the fate and transport modeling. It is possible that degradation rates could vary substantially depending on chemical factors specific to each landfill. As such, it is extremely important that the sensitivity analysis for this factor be done and

[3] U.S. EPA 1996. Soil Screening Guidance. EPA 540/R-96/018. April.

interpreted correctly. Unfortunately, evaluation of the sensitivity analysis was made difficult by the fact that the list of compounds in Table 4-5 versus the table appearing on page F-4 (the sensitivity analysis of the importance of degradation) do not match. It seems dichlorodifluromethane has been omitted from Table 4-5 while cresylic acid is missing from the table on page F-4. This causes most of the CAS numbers on Table 4-5 to be incorrect relative to the associated compound name. Thus, it cannot be determined if the half lives listed in Table 4-5 are similarly "shifted" and whether the sensitivity analysis has been conducted using correct values. It was further not clear to me whether the degradation rates provided in Table 4-5 are for biodegradation alone or if they relate to all of the various loss mechanisms. This is important because the variability in certain loss mechanisms (e.g., volatilization loss) are imbedded in the mass-balance structure of the model such that their variability is adequately handled, whereas hydrolysis rates or biodegradation are input as a constant and variability may not have been adequately addressed.

Finally, it seems that degradation has been included only as a loss term. If it is determined that degradation is appropriate for use in the model and that the uncertainty in the rates can be controlled, then it should additionally be acknowledged that biodegradation may also lead to the production of daughter products (e.g., vinyl chloride) that may have health effects of their own.

5. Adequacy of Uncertainty Discussion

I believe further discussion is required with respect to the contribution to uncertainty of the various models in the body of the text. Currently, uncertainty discussion is more detailed in the Appendices than in the main body of the report. It is not appropriate to expect all risk managers to consult the technical details. It may be of use to include a table within the main body of the text that identifies the order of magnitude change expected for various assumptions applied. This should include quantitative changes associated with alternative modeling approaches.

B. Partitioning Methodology

1. Adequacy of Description and Appropriateness of Methodology

The partitioning approach is well described in Appendix A. Its appropriateness is a different matter. The partitioning approach, as I understand it, essentially treats municipal waste as if it were a "soil". It is possible that this concept may work and, if it does, a major advantage lies in the fact that the required parameter values for this construct are easy to obtain. However, while I would agree that municipal waste may have the same "compartments" as a soil (solid, liquid, and air), the aspects of a real soil that make the equilibrium partitioning model plausible are homogeneity of the matrix and a relatively small grain size (which places the compartments in intimate communication with each other). I am not convinced that these conditions are satisfied for municipal waste. Thus, it may not be correct that the leaching or volatilization limits suggested by application of a K_d would actually occur in municipal waste.

If the nature of municipal waste does not support equilibrium partitioning, I would expect that the worst that could happen would be partitioning to phases limited only by saturation (i.e., vapor saturation or water solubility limits). Thus, it may be possible to check the importance of the partitioning model by using alternative source terms for the volatilization and leaching models (i.e., chemically-saturated vapor and/or water in some volume of the landfill) to see how much different the exposure estimate would be.

Alternatively, empirical measurements of leaching or volatilization rates may be an useful substitute for the partitioning model.

2. Partitioning vs. Leachate Data

In spite of the general caveats *re* the partitioning model, the TCLP alternative does not seem terribly useful. The requirement of the test for acidification is unlikely to drastically affect organic contaminant mobility, and the requirement for reduction in grain size of the test material may actually cause a spurious reduction in leaching by increasing surface area of the immobile phase. As mentioned in the previous comment, it may be more appropriate to conduct leaching and volatilization tests in undisturbed waste "spiked" with solvents wastes (perhaps *in situ* or in a lysimeter). However, recognizing the concern for the heterogeneity of wastes, a substantial number of tests might be required in order to understand the important determinants of contaminant release.

3. Contaminant Availability

(a) Given the concerns with the "structure" of municipal waste, it may be appropriately conservative to assume no matrix effects once the mobile phase exits the source. However, I would not necessarily characterize the approach used in the current risk assessment as assuming no matrix effects to the extent that the partitioning model itself implicitly limits the concentration of solvents in the mobile phase.

(b) One hundred percent contaminant availability is an irrelevant assumption in view of the absence of any justifiable waste characterization. The assumption that has been made is that there is 100% availability of 10.48 grams of solvent contained in a wiper. Because it is unknown how much solvent is actually contained in a wiper, the availability term is not useful. As mentioned previously, it would be more accurate to state that the risk assessment evaluated specific free solvent loadings to a landfill and go on to explain how these data could be used to let risk managers with better data "translate" the results to limits on the number of wipers.

(c) As mentioned above, it was difficult to determine how much difference the biodegradation term makes in the risk estimate. It is, however, notable that significant variance in biodegradation, at least, might be expected in different landfills and this variability must be considered in the sensitivity analysis. Also, biodegradation should be considered a loading term as well as a loss term to the extent the process produces toxic daughter products.

C. Emission Estimation and Landfill Assumptions

1. Time of Availability

I do not known typical landfill procedures, so that I cannot comment on the time of availability for volatilization.

D. Groundwater Transport and Modeling

1. Previous Work of Dilution and Attenuation Factors

The constituents of concern in the present risk assessment are relatively mobile and therefore probably reasonably consistent with the assumptions used in deriving the DAFs for the Soil Screening Guidance. A more important concern is what the application of a high-certainty DAF (e.g. 85% bound on derived DAFs) does to the overall conservatism of the analysis. High-certainty DAFs are larger values than the central tendency, resulting in lower estimated groundwater concentrations. While it is recognized that high-certainty DAFs were applied in the Soil Screening Guidance, other exposure factors in this document were more conservative than the values used here. Thus, this is another parameter value that needs to be incorporated into an analysis of whether the risk assessment has achieved the high-end exposure level specified by U.S. EPA Guidance.

It is also of note that the DAF calculation assumes there is some attenuation in the vadose zone before leachate is subject to horizontal transport in an aquifer. There is no mention of the nature of the typical thickness of vadose zones beneath unlined landfills and it is distinctly possible that no vadose zone exists in some cases (i.e., waste exists at or within the saturated zone). This may add an unknown but unwarranted amount to the generic DAF when it is applied to landfills.

E. Non-Groundwater Transport and Modeling

1. Nationwide Assessment

The Charge from SAIC requests an evaluation of whether use of 29 meteorological data sets is adequate for air transport modeling. Based on the Report, it appears that these datasets were used for sensitivity analysis of landfill cell sizes, not for the overall modeling. Modeling was conducted using meteorologic data from Houston or Lincoln, Nebraska. If this is not the correct impression, then perhaps clarifications should be made in the Report.

If it is true that specific locations were used for dispersion modeling , it is notable that the Houston and Lincoln datasets yield fairly central (Houston) or low (Lincoln) unitized air concentrations relative to other data shown in Table B-6. In view of the concerns expressed in Section 1 *re* the uncoupling of risks from the air versus groundwater pathways, these data may not be sufficient to capture the range of risks necessary to make a regulatory decision.

2. Appropriateness of the Non-ingestion Exposure Calculations

The non-ingestion pathways (bathing/showering) evaluated are appropriate. However, the means used to evaluate risk (using a unitized water concentration) is extremely cumbersome for risk managers who are trying to understand the total risk associated with solvent disposal. Use of this method will produce even greater confusion, should a regulatory decision require some type of "back-calculation" of the solvent loading limit associated with an acceptable risk level. As such, an actual calculation of non-ingestion risk associated with the specific estimated groundwater concentrations should be provided in tabular form, as it

was for risk from inhalation and water ingestion. Alternatively, if the non-groundwater pathway is providing roughly similar increments in risk over the various compounds and landfill scenarios, it might be possible to calculate a "multiplier" to be applied to the groundwater ingestion risk. For instance, one might be able to state that the overall groundwater risk (ingestion and non-ingestion) is equal to "X" times the risk of groundwater ingestion alone.

RTI may also wish to consider if it is useful to evaluate another non-ingestion pathway – the potential for volatiles in groundwater to migrate through the subsurface and into an occupied structure. This was pathway investigated in the Soil Screening Guidance. While this pathway generally demonstrates less risk than the non-ingestion pathways already considered, it provides some information on the risk that might occur in the situation where groundwater is not used for domestic purposes. Thus, risk managers would have useful information for cases of landfills in areas where there is no groundwater withdrawal.

F. Receptor Considerations

1. Constituents of Concern

It is clear where the list of constituents of concern comes from (RCRA listing) and in this regard the list of constituents seems comprehensive. There may be other constituents of concern associated with the businesses using wipers (e.g., metals) but this would have to be established by survey of the industries and may or may not within the regulatory purview of RCRA.

2. Exposure Parameters

The exposure parameters used are well documented, but as previously mentioned, it is of concern that the values applied are not typical conservative estimates. This is not to say that high-end values have to be used for every parameter, but some evaluation is required to assure that the combination of factors used in the risk assessment achieves the high-end level specified by U.S. EPA Guidance. In the absence of this demonstration, it is not clear whether the risk assessment meets the requirements for making regulatory decisions.

3. References for Health Benchmarks

The references for most health benchmarks are standard and appropriate for risk management. However, there is one troubling reference; a citation of a paper on *Risk Assessment Issue Paper For Carcinogenicity Information For Tetrachloroethylene (perchloroethylene).* I am not familiar with this paper and would want to know that it is readily available for review by risk managers and the regulated community. This is apparently the source for the cancer slope factor for trichloroethylene[4], a value which has been absent from the fully-reviewed files on the Integrated Risk Information Service (IRIS) for ten years. The carcinogenicity of this compound has been controversial on both qualitative (evidence of carcinogenicity) and quantitative (cancer slope factor) grounds, so it is important for stake-holders to be able to review this information.

[4] It is confusing that a CSF for trichloroethylene would appear in a document on tetrachloroethylene, but this is the indication in the risk assessment report.

I am assuming that this document is also the source of information leading to the decision not to treat tetrachloroethylene as a carcinogen in the present risk assessment. As this compound is regulated as a carcinogen (despite the absence of an agreed-upon cancer slope factor!) under the Safe Drinking Water Act, CERCLA and RCRA, making a regulatory decision on wiper disposal using an non-cancer interpretation of perchloroethylene risk is not consistent policy. It would be extremely important to have access to the document supporting this alternative approach.

4. Limited Exposure Pathways and Receptors

The receptors and exposures evaluated are reasonably standard and they are appropriate for the purposes of this risk assessment. This includes the non-ingestion groundwater exposure pathways, so it should be perfectly clear in the report that this risk estimate must be added to the ingestion risk pathway. An additional exposure pathway (vapor migration) was suggested in previous comments.

While the selected off-site receptors seem appropriate, it is also necessary to consider potential risk to on-site receptors, i.e. landfill workers. These receptors would not be expected to have high risk from groundwater pathways, but their proximity to solvent sources may make inhalation exposures particularly intense. This would be true especially for machine operators responsible for moving waste and maintaining the daily configuration of wastes in the cells. I have mentioned more than once in these comments that it appears inhalation and groundwater risks are not coupled, so that highest risk at least for certain solvents may derive solely from the inhalation pathway. For these compounds use of off-site receptors may underestimate risks.

Bradley W. Schwab, Ogden Env. Massachusetts
Page 1 tel # 978-692-9090

BRADLEY W. SCHWAB
Principal Toxicologist

SUMMARY OF QUALIFICATIONS

Dr. Schwab has 17 years of experience in toxicology and human health risk assessment and manages complex risk assessment projects for permitting purposes and hazardous waste programs. He has managed many human health risk assessments under CERCLA in 5 different EPA Regions, and many more assessments driven by RCRA and state regulations. He has conducted health risk assessments of both hazardous waste and municipal waste combustion facilities, as well as coal, oil, wood and gas-fired power plants. Additionally, he has served as an expert witness in toxicology as it is applied to risk assessment. He is a Diplomate of the American Board of Toxicology and is licensed as a Hazardous Waste Site Professional by the Commonwealth of Massachusetts. He is an Adjunct Assistant Professor of Environmental Health at the Boston University School of Medicine/Public Health.

EDUCATION

Ph.D./1981/Pharmacology & Toxicology/University of Texas
M.S./1977/Physiology/Harvard University
B.S.Phar./1973/Pharmacy/Northeastern University

PROFESSIONAL AFFILIATIONS

Diplomate, American Board of Toxicology
Licensed by the Massachusetts Board of Waste Site Professionals
Member, Society of Toxicology
Member, Society for Risk Analysis
Member, American Association for the Advancement of Science

PROFESSIONAL EXPERIENCE

Risk Assessment and Regulatory Toxicology

CERCLA Sites: Managed or reviewed baseline risk assessments and preliminary remediation goals for 15 Superfund RI/FS projects (some of these are detailed in project descriptions below) including: Darling Hill Dump (Vermont, Region I) - managed baseline health and ecological risk assessment, Old Southington Landfill (Connecticut, Region I) - managed baseline health risk assessment, Savage Municipal Well Site (New Hampshire, Region I) - managed baseline health risk assessment and remedial recommendations for hexavalent chromium; Parker Landfill (Vermont, Region I) - data analysis for U.S. EPA-lead risk assessment; LI&RR Site (Rhode Island, Region I) - critique of Record of Decision; Re-Solve Site (Massachusetts, Region I) - analysis of risks of remedial action; Solvent Recovery Site (Connecticut, Region I) - analysis of remedial actions achieving adequate risk reduction; Industri-plex (Massachusetts, Region I) - project toxicologist for baseline health and ecological assessment; 57th Street School Site (New York, Region II) - managed baseline risk assessment; Foundry Cove (Marathon Battery) Site (New York, Region II) - critique of risk assessment; UOP Site (New Jersey, Region II) - managed baseline health risk assessment; Live Oak Site (Florida, Region IV) - managed baseline health risk assessment; Motorwheel Site (Michigan, Region V) - preliminary risk assessment; Waite Park Site (Minnesota, Region V) - peer review of baseline risk assessment; Koppers, Texarkana site (Region VI) - initial baseline risk assessment; French Limited Site (Texas, Region VI) - critique of risk assessment.

Old Southington Landfill PRP Committee: Assisted in the design of a field sampling program (soil, groundwater, surface water, sediment, air, soil gas) and authored workplan and reports on Remedial Investigation and Baseline Health Risk Assessment of the Old Southington Landfill NPL site. Presently providing expert witness services in toxic tort actions associated with the site.

Savage Municipal Well Site PRP Committee: Managed Baseline Health Risk Assessment for this NPL site in southern New Hampshire. Provided statement and deposition on the nature of compounds causing most concern for risk in a cost recovery suit against PRP's insurance carriers. The case was settled.

UniFirst Corporation, Indian Orchard, MA. Providing human health Risk Characterization of potential groundwater releases to support a Phase II completion at this Tier 1A Public Involvement Plan site. Part of this ongoing work included design of a flux-chamber study to evaluate vapor migration from the subsurface, submission of a workplan for the same (approved by Massachusetts DEP) and submission of a Risk Characterization Workplan (approval pending).

Massachusetts Electric Co. - Staff scientist for a Method 3 Risk Characterization of a former manufactured gas plant site. Developed exposure models to evaluate exposure to volatile compounds released to the ambient air or into trench space from vadose soils.

Phoenix Research: Provided characterization of the acute human toxicity of arsine gas for an appeal of a notice of violation before the Air Quality Management District Board of Appeals. Provided expert witness testimony regarding the likelihood that individuals would suffer health effects if an accidental release were to occur.

Confidential Client, Pennsylvania: Providing litigation support services related to insurance claims for CERCLA site remediation. Researched and developed a "time-line" of toxicological information on arsenic, indicating that while the metal has been known to be toxic and carcinogenic, there is no direct evidence to this day that toxicity occurs at very low doses, such as those experienced in the environment.

Confidential Client, U.S. Virgin Islands: provided information on toxicology of hydrocarbons and mercaptans after a release produced odor problems and acute illness in workers at docks adjoining an oil refinery. Briefed local health professionals, territorial senators, and environmental regulatory officials on appropriate concentration limits to protect health that could be incorporated into ambient monitoring plans during future procedures at the refinery.

Confidential Client, New Jersey: Providing litigation support services to company defending a property and toxic liability suit based on neighbor's claims to having been exposed to cadmium and other metals in air emissions.

Confidential Client, New Jersey: provided information on toxicology of cracker catalyst after an upset release from a petroleum refining unit. Participated in meetings with neighbors concerning potential effects and means to prevent future releases.

BP Europe: managed a project to develop decision tree for how to proceed with risk assessment for all environmental sites to be investigated for BP. Main criteria were the site's potential to cause harm to human health and the regulatory status of the site. Working with BP's independent software applications consultant to develop risk estimating software. Currently expanding the software to include probabilistic assessment and ecological evaluations. Wrote a "standard language template" for all risk assessment reports to be submitted by BP contractors to U.S. federal or state authorities.

Hickson Corporation, Conley Georgia: Managed a "fast-track" human health and ecological risk assessment of a chromated copper arsenate (CCA) production facility under new regulations promulgated by the Georgia Environmental Protection Division. EPD set a regulatory deadline of six weeks for the work, after which cleanup criteria would revert to background if the work were not acceptable to the state. Ogden worked closely with the client and Georgia EPD staff to develop an acceptable risk assessment protocol. Human health evaluation was conducted for present and future workers based on a demonstration, using county planning documents, that the site was highly likely to remain industrial. All potential site constituents, with the exception of copper, chromium, arsenic, and lead were eliminated based on comparison to local background conditions. With the approval of Georgia EPD, used a geostatistical approach (ordinary kriging) to develop a spatial exposure point concentrations. Concluded that on-site portions of the stream did not constitute critical habitat and therefore did not require quantitative evaluation in the ecological risk assessment. However, offsite portions were deemed to be important and potentially affected by releases from the facility. Used both screening (ecological benchmarks) and laboratory study (sediment toxicity tests done in the Ogden Aquatic Toxicology Laboratory) to evaluate potential for ecological impact. Found that while benchmarks were exceeded, laboratory results indicated little acute toxicity. The work was completed within the six week time frame and was acceptable to the Georgia EPD.

National Council of the Paper Industry for Air and Stream Quality: Task manager for review of the Great Lakes Water Quality Initiative. Reviewed exposure and toxicity assumptions used to derive water quality criteria for several chemicals, with emphasis on mercury. Commented to the U.S. EPA that toxicity values for mercury and others are driven by "uncertainty factors" rather than the data, and that exposure assumptions were not well supported. Reviewed all literature cited by U.S. EPA related tot he uptake and toxicity of mercury in aquatic species and humans. Several difficulties in application of the literature data to deriving water quality criteria, including inappropriate bioconcentration factors and oversimplified assumptions concerning the biogeochemistry of mercury in aquatic systems. Co-published a paper with NCASI showing that water criteria two orders of magnitude higher than those proposed by U.S. EPA could be supported by literature data and suggesting ways of reducing the uncertainty associated with criteria derivation.

Integrated Waste Services Association: Prepared a report identifying new epidemiologic information on mercury toxicity and alternative analyses of the data used by U.S. EPA to develop a new Reference Dose for methylmercury used in the *Mercury Study Report to Congress*

Paper Manufacturer, Bellingham Washington: Aided in designs of a field sampling program and provided risk assessment reports under the Washington Model Toxics Cleanup Act (MTCA) for mercury remediation of areas surrounding a chlor-alkalai (mercury cell) production facility. Showed that substantially different levels of residual mercury could be left in soil, depending on whether one need be concerned about this media providing a source for surface water contamination. Thus, if surface runoff and groundwater capture were instituted (as planned), one could determine acceptable levels of residual mercury in soil based only on occasional direct contact with soil by workers (the site has ongoing pulping and paper production operations). The "direct contact" acceptable concentration was several orders of magnitude higher than that based on preventing potential transfer to surface water.

Confidential Clients - Prepared comments on U.S. EPA's Draft Soil Screening Guidance after review of the Soil Screening Guidance Fact Sheet and Technical Background Document. Found the guidance to follow a generally tenable approach, but expressed much concern over so-called generic soil screening guidance. Identified several places where "default" inputs to the generic soil screening levels were poorly justified and probably not applicable to many CERCLA sites. Noted that uncertainty associated with the inputs was ignored. Thus, recommended that soil screening focus on site-specific approaches and that statistical inference for screening must include an accounting of the uncertainty in the soil screening level, not just the uncertainty in soil analytic data.

BP America Environmental Research Center - served as reviewer on an expert panel formed to determine appropriate, risk-based, approaches to substitute for the Total Petroleum Hydrocarbon standard used by many state regulatory authorities.

U.S. Generating - Project manager for a health and ecological risk assessment of emissions from a coal and oil fired co-generation unit in Jacksonville, Florida. Compared the potential impacts of emissions of organic and inorganic emissions, including metals (Hg, As, Ni, Vd, Cd, Cr), from a circulating fluidized bed cogeneration unit, supplemented by three distillate oil-fired package boilers to the impacts produced by the steam/power configuration the project was intended to replace (bark boilers and residual oil-fired power boilers). Additionally considered risk from radionuclides in coal using U.S. EPA and DOE methods. Demonstrated that, on balance, the new units would be expected to have less impact than the current boilers, causing the project to have a net health and environmental benefit.

Ogden Aviation - Conducted risk assessment of BTEX as part of a site characterization following a release of Jet-A fuel from its bulk fuel storage facility at Dulles International Airport.

Confidential Client - Performed a baseline human health risk assessment of an NPL site in Region III to demonstrate that a large range of potential risk would be estimated, depending on the projected use of the property. The PRP-lead assessment considered commercial use of the property because the site had never been used for residences, was not residentially zoned, and was being considered for deed restriction to limit land use. Showed that while residential use of the property would result in risk outside the U.S. EPA target range if assessed using "default" exposure parameters, use of more realistic residential exposures and use of both conservative and realistic commercial exposure scenarios resulted in risks within or below the target range.

Wood-treating Facility - Assessed the potential health effects due to surface soil contamination with polynuclear aromatic hydrocarbons (PAH), pentachlorophenol, polychlorinated dibenzo-p-dioxins and dibenzofurans, and groundwater transport of pentachlorophenol and light aromatics to surface water. Remedial action was required to address potential health effects from exposure to surface soils, but soil contamination was heterogeneous. A Monte Carlo simulation of exposure to soil-borne contaminants illustrated the uncertainty of significant exposure occurring and the subsequent conservative cleanup levels, based on assumptions concerning the probability of soil contact in "hot spots." Groundwater modeling indicated minimal health or environmental effects. Negotiated and developed cleanup levels for soil under the Model Toxics Control Act of the State of Washington. Worked with remedial engineers to assure cleanup levels were developed to facilitate selected remedial technologies.

Trade Organization - Member of a committee of toxicologists reviewing the draft of the Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles in order to respond during the public comment period.

Trade Organization - Served on a committee of toxicologists organized to develop Health Protection Guidelines for determining the water quality impacts of production wastes in the petroleum industry.

Clean Harbors of Braintree - Participated in scoping the health effects assessment portion of the study for the developer of a proposed commercial hazardous waste incinerator. Developed protocols for the study and completed the chronic health risk assessment for inclusion in the Preliminary Project Impact Report. Managed the subcontract to conduct a telephone survey of approximately 2,000 homes to determine the baseline health status of the host and similar communities. Participated in negotiations and presentations to regulatory authorities and the public.

<u>Other Professional Activities</u>

Department of Environmental Health, Boston University School of Medicine/Public Health - Adjunct Assistant Professor. Course director for 2 graduate courses in human health risk assessment. Faculty sponsor for independent research projects in environmental health. (1991- present).

Vermont Agency of Natural Resources - Appointed member of the State Toxicology Advisory Committee (1994 - 1998).

New Hampshire Department of Environmental Protection - Member of Science Advisory Committee for an NCI-funded study on the use of State Public Health Databases to detect and prevent cancer. (1991).

National Academy of Sciences - Consultant to the Safe Drinking Water Committee preparing Volume 6 of Safe Drinking Water and Health under contract to the U.S. EPA. (1985)

Department of Environmental and Industrial Health, University of Michigan - Co- principal investigator on NIH grant to study biomarkers for neurotoxic diseases, specifically pesticides. Also conducted experiments aimed at isolating proteins associated with neurotoxic disease and investigation of neurophysiologic correlates of morphologic change observed following exposure to organophosphorus (insecticide) compounds. (1983-1985).

Institute of Neurotoxicology, Albert Einstein College of Medicine - Principal investigator on preclinical studies of tranquilizing agents for neurotoxic effects and quantitative morphologic techniques. (1981-1983).

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